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ABSTRACT

The uses of computers in the classroom are discussed, and the implications of these uses in an information-based society are addressed. Three types of computer applications are examined: learning about computers and their relation to society, including computer programming; learning through computers, which includes drill-and-practice, diagnostic testing, and tutorial programs; and learning with computers, which is using the computer as a tool of instruction and creating an environment where learning may occur. Some fear that in the rush to include computers and computer literacy in the school curriculum, the teaching of reading, writing, and mathematics will be put aside. Another issue is that access to computers in schools may differ along socioeconomic lines. The proportion of elementary and secondary schools having microcomputers for instruction is increasing in the 1980s. However, southern elementary schools are less likely to have a microcomputer than elementary schools outside the South. Colleges and universities are moving to include computer training for teachers at both preservice and inservice levels. Nationally, several states now have teacher certification in the area of computer education. To address the problems of inadequate software, district, state, and national level efforts are underway. (SW)

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REGIONAL SPOTLIGHT

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Computers in Education: Implications for Schools and Colleges

College graduates of the year 2000 are kindergarten children this year. Will these students be prepared for the workplace and the demands of society in the year 2000? What about those students who will have completed a high school education or less, or have attended other postsecondary institutions? We cannot be sure what the demands of the future will be, but it is certain that the technological innovations of today are just harbingers of what will be available in the future.

As the information revolution begins to make demands on elementary-secondary schools and on higher education institutions, policymakers are facing difficult decisions. There are no easy answers, and at the moment the issue is complicated by controversy about the quality of the schools and their ability to prepare students to enter college or the vocations.

Resources for education are limited. Institutions of higher education face declining resources as well as unstable enrollments. What is the role of higher education in meeting the challenges of the technological revolution as it relates to the education of all children in elementary and secondary schools? Are colleges and universities effectively preparing teachers to use technologies in the classroom? Are institutions initiating research to determine effectiveness and efficiency in teaching children? Is the technical expertise of university faculty being shared with schools? Are elementary-secondary schools using the resources that may be available, or could they be duplicating efforts? Are the elementary-secondary schools providing each student with the necessary background to enter a college, university, or other postsecondary program? Who is deciding what a student needs to know at the fifth- or seventh-grade level or upon graduating from high school?

The Information Society and Education

"We have moved into an Information Age which has caused a major social, economic, and structural change in our society. We are . . . building a new foundation around computers, communications and information." This assessment comes from Andrew Molnar of the National Science Foundation. The Office of Technology Assessment (OTA), a research organization for Congress, notes that, in this ever-changing society, demands for easy access to large amounts of information will increase. Many functions of society — banking and financial services, government agencies, national defense, corporate operations — now depend on information technology. Communications capabilities, such as cable linkages, satellite communications, and digital telephone networks, are being used extensively, and have the capacity for handling large amounts of information. Resources for storing and processing information and the use of video technology are increasing. Computer technology is improving so rapidly that access to computers, especially the desktop microcomputers, is becoming widespread. These microcomputers are relatively inexpensive, and have capabilities previously restricted to large and costly main-frame computers.

The OTA predicts that information technology will continue to have a great impact on all social institutions that depend on and use information. Therefore, our educational institutions will be greatly affected by the information revolution. If literacy is defined as the ability to engage in information exchange in society, then the inclusion in one's education of retrieving and transferring information through technology is becoming increasingly important.

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At the elementary and secondary levels, the use of electronic technology over the years has been limited. This is changing with the growing use of microcomputers in the classroom. In light of these changes, the computer in the classroom needs to be examined to determine its uses and implications that these uses have in an information-based society.

Use of Computers in Education

Issues of elementary and secondary education focus today around questions of the purposes of public education — the primary ones are undoubtedly competency in reading, writing, and mathematics. In question is whether or not the introduction or use of computers in the classroom will detract from or reinforce that mission. Surrounding that issue are questions concerning whether funding is being diverted away from other purposes to acquire computers for schools and whether or not all students can have access to computers. Will the focus of the use of computers be different for students from different backgrounds? Are computers another educational fad and in a few years will they be gathering dust in school storerooms? What is computer literacy? Who is defining what it is students need to know about computers? How are computers being utilized in the schools? Are teachers being trained effectively to use computers in the classroom?

Three Kinds of Computer Education

The use of computers in education has given rise to various designations, often meaning the same thing but using different terms. Some of these terms are computer literacy, computer-aided instruction, and computer science. The term "computer-aided instruction" (CAI) may refer to all the types of uses that relate to instruction, such as drill-and-practice, tutorial programs, simulations, and educational games; or it may simply refer to drill-and-practice or tutorial uses. Computer science usually focuses on programming.

In a recent issue of *Phi Delta Kappan*, Decker F. Walker, professor of education at Stanford University, identifies several ways in which a microcomputer can be used as an aid to education. They include more active learning; a variety of sensory modes, such as sound, color; the linking of computers to scientific and video equipment; learning with less drudgery, such as using word processing for rewriting drafts and searching library catalogs; learning nearer the speed of thought; individually tailored, more independent learning, with verification of progress; and using the computer as an aid to abstraction, such as in viewing three-dimensional figures. He sees computers as supplemental, not as a substitute for teachers. Ernest L. Boyer in his 1983 report, *High School: A Report on Secondary Education in America*, classifies the area of computers in education as "learning about," "learning with," and "learning from."

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It is evident that terminology often is not specific and may have different meanings in different contexts, yet it is important to understand the different applications and how they may be utilized in the classroom. In our discussion we will use the categories suggested by the National Science Board's Commission on Precollege Education in Mathematics, Science, and Technology in its recent report, *Educating Americans for the 21st Century*. The three categories are:

1) learning *about* computers, which in its early stages involves learning about computers and their relation to society and later includes computer programming,
2) learning *through* computers, which includes drill-and-practice, diagnostic testing, and tutorial programs, and
3) learning *with* computers, which is using the computer as a tool of instruction and creating an environment where learning may occur.

The Commission notes that the second category has been the focus in terms of effort and dollars spent, but that the last category *(learning with)* is the most promising use of computers in education. Included in the category of *learning with* computers are micro-based systems to permit exploration of real world phenomena, data bases for information accessing, and tools including word processing, graphing, problem-solving, simulations — among others.

Learning about Computers

Learning about computers — often termed "computer literacy" — is the major focus of many efforts to implement the use of computers in classrooms. In a 1983 national survey conducted by Henry J. Becker of the Center for Social Organization of Schools at Johns Hopkins University, teachers were asked to report their use of microcomputers in the classroom. "Introduction to computers" was the most prevalent activity at the elementary level. At the secondary level, nearly equal emphasis was given to programming instruction. In schools that obtained their first microcomputer two or three years ago, the shift seems to have gone from drill-and-practice to emphasis on teaching students *about* computers and how to program them.

The term "computer literacy" may already have become one of those overworked, and sometimes meaningless, terms associated with education. As long ago as the late 1960s, educators in the fields of computer science began to realize that everyone needed to know *something* about computers. Early reference to "computer literacy" in the schools focused on computer awareness, with students talking about computers but spending little, if any, time working with them.

In 1972, the Conference Board of the Mathematical Sciences' report, *Recommendations Regarding Computers in High School Education*, suggested that "universal computer literacy" be a goal, and that a junior high school course be offered in computer literacy. To Joseph Weizenbaum, professor of computer science at Massachusetts Institute of Technology, "computer literacy" means a commonsense attitude toward technology, but not an in-depth knowledge of computers. Dr. Louis Robinson, director of university relations for IBM Corporation, defines computer literacy as the ability to use computer technology in a discipline. He feels that it does not imply an accomplished capacity to program.

A recent Educational Testing Service (ETS) publication reports that computer literacy usually represents a "threshold of knowledge that qualifies an individual for participation in the computer age." It is noted that considerable disagreement looms over just where the threshold lies. The National Commission on Excellence in Education in its report, *A Nation at Risk*, does not use the term "computer literacy," but identifies computer science for high school students as one of the "five new basics." Computer science, as used here, includes understanding the uses of the computer, being able to use the computer for study, work, and personal services, and understanding the world of technology.

Ernest Boyer calls, not for "computer literacy," but for "technological literacy" so that students will understand how inventions reshape society and how to use the latest inventions responsibly. He maintains that learning about computers and their impact on society and on students' own lives has high priority for the use of computers in the schools.

Nationally, the Department of Education has formed a task force to work with two organizations, the Educational Testing Service and the Human Resources Research Organization (HUMRRO), to delineate computer literacy. The assumption is that computer literacy will be defined differently for different groups of persons. A forthcoming survey with a large pool of questions will be made available to states and districts, so that not only can they measure the use of computers in the schools but also determine the different levels of use.

For the college-bound student, the College Board has included computer competencies among the requisite tools cataloged in its *Academic Preparation for College* report. It sees effective use of the computer as an essential prerequisite in acquiring knowledge, organizing systems, and solving problems. In addition to the basic knowledge of computers, it lists the ability to use the computer and appropriate software for data collection, word processing, simulation modeling, and problem-solving. It visualizes the student being able to use existing programs for the above uses, as well as possibly developing additional programs. How computers can be used in academic disciplines and in studying societal issues is also seen as part of the training of college-bound students.

The College Board's Advanced Placement (AP) program has just added a course in computer science. It covers topics that would be included in six or more hours of a first-year college computer science course. Its purpose is to serve those students who will major in computer science, as well as those who need a computer science background for other disciplines. The course emphasizes programming methodology, with PASCAL as the programming language, and also includes the general competencies outlined in *Academic Preparation for College*. A difference is that while all students are encouraged to be able to use software, only students completing the AP course are expected to be able to *create* software.

The International Council for Computers in Education, which focuses on the use of computers in the pre-college setting, defines computer literacy as a "functional knowledge of computers and their effects on students and the rest of society," as well as knowledge about how computers can be used for learning and solving problems. It maintains that knowledge of computers is essential to the understanding of academic areas outside of computer science.

In *Action for Excellence*, the report of the Task Force on Education for Economic Growth, computer literacy is listed among the competencies that students should acquire for productive employment. Included are the following computer literacy competencies: the ability to operate computer equipment, follow procedures that are

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predefined on the computer, and understand the basic function of computer devices.

Learning through Computers

For the present discussion, learning *through* computers focuses on drill-and-practice and tutorial programs. At the elementary level, frequency in these uses of the computer in the classroom is second only to learning about computers. A larger share of these uses is reported by elementary schools (59 percent) than by secondary schools (31 percent), according to the Johns Hopkins' survey. Elementary schools in the South that have microcomputers are reported to be using them for drill-and-practice to a greater extent than other regions of the country.

One example of learning through computers is a program designed to help elementary teachers teach language arts. The teacher enters lists of spelling words and, in turn, the program drills students in correct spelling of the words by presenting them in mixed-up order or in word puzzles. Other language arts programs might drill in specifics like alphabet sequence or use of prefixes or suffixes. A preponderance of drill-and-practice and tutorial programs is available in mathematics, especially at the elementary level.

A great deal of research on the use of computers has focused on computer-aided instruction in the classroom, and several studies indicate positive results when compared to traditional methods.

A University of Michigan study by Kulik and associates, which analyzed the results of studies conducted over the last 10 years for grades 6 through 12, found that students who received some sort of computer-based instruction fared better than those who did not. In addition, their attitude was more positive. In a study conducted in the Los Angeles city schools examining the effects, over a four-year period, of the use of computer-assisted instruction in remedial education, Marjorie Ragosta of the Educational Testing Service found that there was a direct relationship between the amount of time the Los Angeles student spent per day using computer-assisted instruction and his or her improvement in the level of mathematics achievement.

A study conducted in Oregon concluded that computer-assisted instruction in reading, mathematics, physics, foreign languages, and social studies showed more positive results in student learning and attitudes than did traditional methods. In contrast, a study conducted by Karen Sheingold at the Bank Street College of Education in New York City found very little evidence that the use of microcomputers aided student learning. However, social relations were affected — with computer-assisted students interacting to a greater degree and with more focus on tasks at hand.

Becker, examining the results of his work at Johns Hopkins, questions whether the use of computers for drill-and-practice is cost effective. He notes, however, that student attitudes are shown to be more positive when computers are used in the classroom. Teachers also report that students using computers tend to work together more cooperatively, and require less assistance from teachers.

The Johns Hopkins study also examined computer usage in lower socioeconomic schools. In schools with high minority enrollment, computer usage focuses on drill-and-practice for low ability students. On the other hand, in the predominantly white schools that were observed, microcomputers are being used with *higher achieving* students for programming and for independent work. Becker notes that the two different approaches to students from less affluent backgrounds indicate two philosophies on the appropriate use of computers in the schools. In the second instance, students with less ability are presumably being given more individualized attention by teachers, leaving the more able students to work independently with computers.

The National Science Board's Commission notes several advantages of learning through computers, such as a body of research which points to greater effectiveness as compared to traditional instruction, the low cost and relative ease of preparing software programs, and the flexibility in allowing instruction to be geared or paced for individual students. It notes that this use of the computer is a "computer-controlled learning mode" and caution must be exercised in its use, but that it is useful in a total approach to implementing the use of computers in the classroom.

Learning with Computers

Using the computer as a tool or to create an environment for learning takes many shapes — data-gathering and manipulation, problem-solving, simulations, to name a few. For instance, computers may be used to develop writing skills from early elementary years through college.

. . . learning with computers offers rich opportunities and will probably be the most important future use. . . .

Programs may lead students through the organization of sentences into paragraphs, with prompting to aid students in clarity and style. Microcomputers can monitor scientific experiments and help students analyze data. Sounds can be reproduced for students composing music.

Another mode combines the use of computers and video equipment. For example, a history lesson may have pictures of events to reinforce the narrative. Graphics may present mathematical models (such as an x-y graph) for different values, allowing the student to see differences in the graphs as variables change, rather than spending most of his or her time and energy on plotting the numbers to produce a line. One program illustrates investigating alternative means for the eradication of malaria — using drugs for treatment or prevention, using pesticides, or hospitalization — and asks students to integrate economic and ecological goals through a decision-making process.

The report of a 1982 research conference sponsored by the U.S. Department of Education, "Computers in Education: Realizing the Potential," maintains that research is needed to determine new roles for teachers, new organizations for classrooms, and new educational settings, as well as research on the uses of computers, basic cognitive research, and how schools can become communities of computer users. It also suggests that research centers be established to develop successful applications of computers through collaborative efforts of experts in subject matter, computer technology, teaching, and cognitive-science areas. The report concludes that improvement in educational computer systems is attainable if a sustained and coherent research investment is available. Such a research effort could also guard against dangers that might be inherent in the use of computers in schools, such as isolation of students or the effect of systems which use the new technologies in harmful ways.

Programs to utilize the computer as an instructional tool with which to learn are the most expensive and difficult to create and, at this time, little is known about their value as supplements to classroom activities. Becker reports that the Johns Hopkins' research on the use of simulations has not been positive. However, the National Science Board's recent report notes that learning with the computer offers rich opportunities and will probably be the most important future use of computers.

> . . . schools should not be overwhelmed, but neither can they ignore the rush to technology.

Diversion or Enhancement?

Experts in computer and educational fields see the computer affecting schools in different ways, but all generally agree that their use in schools is here to stay and is increasing rapidly. In the past, technological innovations for classroom instruction were not used extensively outside the schools and, therefore, the push to use some of the earlier technology was not as evident as the present drive to use computers in the classroom. Stanley Pogrow states in a *Phi Delta Kappan* article that current technologies will have a widespread impact if they are widely accepted into homes and become a primary tool for work. He sees that time as fast approaching.

Professor Melvin Kranzberg, of Georgia Institute of Technology, an authority on the history of technology, sees the educational use of technology as proceeding more slowly than envisioned by many. He notes that schools should not be overwhelmed, but neither can they ignore the rush of technology.

Marc Tucker of the U.S. Department of Education's Project on Information Technology maintains that computers are not the solution to problems in our schools at the present time. He believes that schools will have to make agonizing choices in the next years in regard to computers. These choices center on whether the money to be spent on computers could be better invested in something else, and how much classroom time should be devoted to computer use.

David Moursund, president of the International Council for Computers in Education, sees computers as an increasingly important mode of instruction over the next 30 years. He sees a gradual acquisition of computers until a critical mass is achieved, at which point the growth of computers will bring about rapid changes in the schools. Seymour Papert of the Massachusetts Institute of Technology envisions that, by the end of the century, all kinds of technology will have transformed education, so that the conventional classroom of today will no longer exist. Alfred Bork, director of the Educational Technology Center at the University of California at Irvine, sees the use of computerized instruction as the only hope for students in many rural areas to receive quality instruction in mathematics and science.

Some fear that, in the rush to include computers and "computer literacy" in the curriculum, the teaching of reading, writing, and mathematics will be put aside. While these fears may be unfounded, the place of the computer in the schools must not be defined too hastily. Present definitions will certainly need to undergo changes as technology and availability of software evolve. Industry warns that large numbers of workers who can program computers are not needed but, instead, persons who can read, write, analyze, and solve problems are. In examining the uses of technological approaches to education, the OTA has stated that not enough is known about their positive or negative effects on learners, so caution should be exercised in national efforts to introduce technologies into education.

Computers in Schools — Equal Access?

Students are not spending much time on computers presently, but as schools move to acquire computers at a fast moving pace this will change. However, there is already evidence that access to computers in schools may differ along socioeconomic lines.

Attitudes of students toward the use of computers in schools appear to be generally positive. The latest Gallup survey showed that 44 percent of the teens surveyed favored a minimum competency test in computer science as a requirement for high school graduation. The 1982 National Assessment of Educational Progress (N.A.E.P.) results showed that three-fourths of 13- and 17-year-old students thought computers were useful for teaching mathematics and made math more interesting. These percentages were up from a 1978 assessment. The survey analysts warn, however, that the term "computer" in this instance may have been interpreted to mean calculators or even video games.

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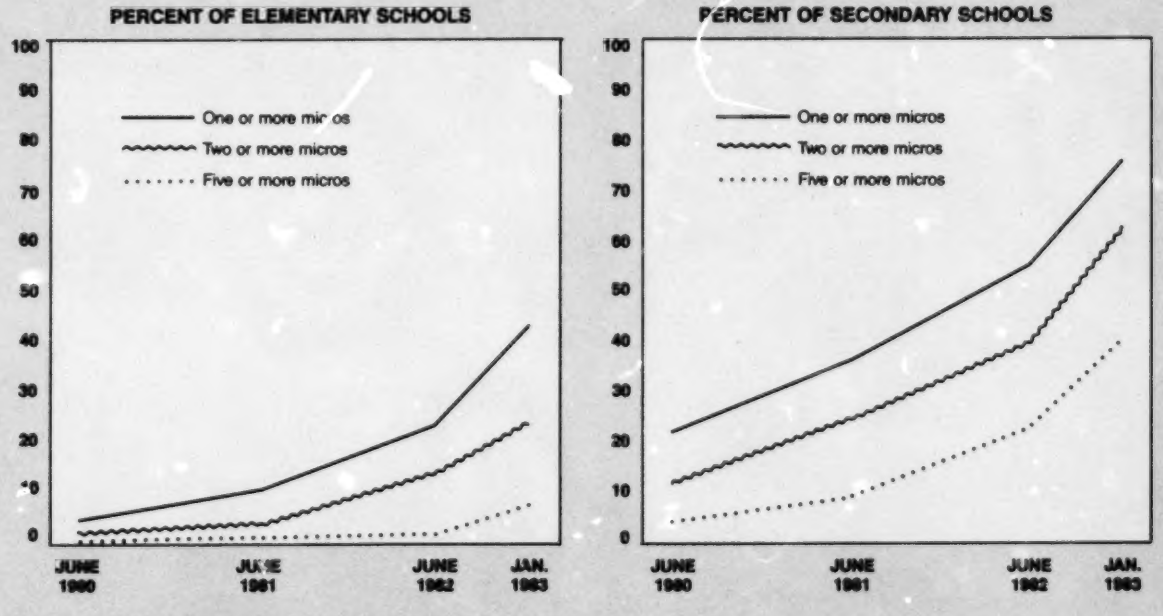
Surveys on the use of computers may be misleading because often they focus on schools having computers, rather than on the actual exposure of students to computers, and because schools are acquiring computers at a rapid rate. A survey by the National Center for Education Statistics reported that in 1981-82, 35 percent of the secondary schools and 22 percent of the elementary schools had computers. The January 1983 Johns Hopkins survey reported that 85 percent of the high schools in the United States had at least one microcomputer, compared to 42 percent for elementary schools. The findings indicate that the smallest high school is more likely to have a microcomputer than the largest elementary school.

Schools are becoming new users or multiple users of microcomputers at a fast rate (see figure). According to the report, the most significant change is that the proportion of secondary schools having five or more computers doubled from June 1982 to January 1983. The National Science Board estimates that the number of schools using microcomputers for instruction increased over 300 percent from October 1981 to October 1983 (data

Microcomputers in Schools: 1980-1983



Results based on a sample of 2,000 public and private schools in the nation.

Source: *School Uses of Microcomputers*, Issue I, April 1983. Center for Social Organization of Schools, Johns Hopkins University, Baltimore, Md.

provided by Market Data Retrieval). However, the Johns Hopkins survey notes that even though a majority of the nation's schools have microcomputers, this does not necessarily mean that a majority of students have access to computers or that the students get much time on a computer. It reports that around 13 percent of the students in secondary schools have access to the computers. While 16 percent of the elementary school students have access, they get less exposure time than secondary students. It appears that secondary schools give longer access to a smaller number of students.

As might be expected, the studies by Johns Hopkins and others show that schools in wealthier districts are more likely to have computers. Two-thirds of the schools in these districts have microcomputers, compared to around 40 percent in the less affluent districts.

How do the Southern states compare to the rest of the nation in use of computers? A survey, using the 1982 N.A.E.P. data, reports that regional disparities exist. Twenty-five percent of students in the West indicated that they have used a computer in school compared with 12 percent in the Southeast. There seems to be less disparity by race and sex than by area of the nation. The report did note that female students and students in economically disadvantaged schools were less likely to enroll in computer programming courses. Southern elementary schools, according to information from the Johns Hopkins survey, are less likely to have a microcomputer (29 percent of the schools) than elementary schools outside the South (48 percent).

Southern elementary schools . . . are less likely to have a microcomputer than elementary schools outside the South.

Teacher Training in the Use of Computers

A recent nationwide survey by the National Education Association found that approximately 20 percent of the teachers sampled have had computer training, but the extent of that training was not determined. Over half of the teachers listed a college or university as one of their sources of training, almost double the number listed for any other source (see Table 1). Most teachers reported that they are not well-informed about computers, but a majority are *interested* in instructional applications and how to operate a computer.

Calls for enhancement of teacher training in the use of computers in the classroom are being heard from many sources. Harold Howe II, former U.S. Commissioner of Education, feels that funding and arrangements for teacher training must be shouldered by someone other than teachers — to expect teachers to take the complete responsibility, or most of it, for their own training is to doom the use of computers in schools.

The 1982 National Science Foundation's five-year outlook asserts that a restructuring of teacher training and retraining will be needed for schools to realize the potential of recent technology. The National Science Board's 1983 Commission on Precollege Education in Mathematics, Science and Technology recommends that regional education centers be established to train teachers in using new technologies. Ernest Boyer also recommends establishing federally-funded centers on university campuses to educate teachers. Arthur Luehrmann, author of textbooks in the field, argues that teacher training in the use of computers is a critical need that should be addressed through federal initiatives. Teachers who are trained to teach high school computer science courses are in especially short supply.

Table 1

Sources of Computer Training for the 20% of Teachers Who Have Such Training

	Percent of those trained*
College or university	53
Local school district	29
Self-taught	29
Computer manufacturer	13
Other†	9

*More than one source of training was reported by some teachers

†Teacher centers, technical or computer schools, National Science Foundation, military

Source: Norman, Carol. *A Teacher Survey NEA Report: Computers in the Classroom, 1983.* National Education Association (Washington, D.C.: The Association, 1983) p. 16.

College and University Actions

David Moursund's 1982 study noted that only five percent of over 1,000 teacher training programs offered computer training. However, 81 percent of the institutions responding to a 1983 survey conducted by the Task Force on Instructional Technology of the American Association of Colleges of Teacher Education offered at least one degree or certification program in educational technology. Classes were offered for pre-service teachers in two-thirds of the programs, and one-fifth of the institutions made such a course a requirement in their programs. Programs to train teacher education faculty members in the use of microcomputers were underway in 55 percent of the colleges. In-service programs for classroom teachers were being provided by 63 percent of the reporting institutions.

Problems related to teacher education programs include a lack of

faculty interest and expertise in the education schools and in the disciplines. In addition, faculty in computer science departments are often not familiar with the uses of computers in schools (aside from the technicalities of computers) and, consequently, may not be able to help prospective teachers understand the best use of computers in the classroom.

Robert Taylor, director of the program in Computers, Communication, and Information Technology at Columbia University's Teachers College, has been involved for several years in identifying needed policies for both pre-service and in-service education of teachers. Courses at Teachers College include programming, the use of computers in the disciplines, software development, and evaluation. In an August 1983 article in *Popular Computing*, Dan Watt notes Taylor's belief that programming is at the heart of what the teacher needs to know. According to Taylor, educational leaders at the state, district, and institutional levels often know little about computers and the broad issues involved, and therefore have difficulty in providing training for teachers. He advocates statewide teacher training provided through colleges of education and local plans that would include periodic retraining to keep pace with the rapidly occurring changes in the field. His idea is that local districts should put pressure on state departments of education and colleges to provide training for teachers.

> . . . to expect teachers to take the complete responsibility, or most of it, for their own training is to doom the use of computers in schools.

Colleges and universities are moving to include training for teachers at both pre-service and in-service levels. The University of North Alabama funded a computer laboratory for its College of Education in the fall of 1982. Since then, all teacher education faculty have been trained to use computers. All education students are now required to complete a sequence known as the Computer Literacy for Teachers program. The emphasis is not on programming, although PILOT and LOGO are taught as useful languages for instruction. According to James Burney, the program now includes in-service programs for teachers in area schools. The College has also been able to offer limited numbers of classes on computer literacy for children. At another Alabama institution, the University of Montevallo, all prospective teachers are being taught to use the computer as an instructional tool. At the University of South Alabama in Mobile, microcomputer literacy is being integrated into the undergraduate and graduate curriculum in teacher education. In addition, the College of Education is providing faculty development programs in the use of microcomputers in the college classroom.

Louisiana's Northwestern State University has established a Center of Computer Literacy to develop a scope and sequence for computer literacy for grades K-12, as well as to provide courses for educators, businesspersons, and parents and children.

Arkansas State University at Jonesboro has approved a computer literacy requirement for its teacher education graduates, and several other Arkansas institutions are considering a similar move.

At the University of Virginia, microcomputers are being used in programs to prepare elementary teachers. Prospective teachers practice their teaching skills on computer simulations of student situations, which can be changed. The method appears to have promise as a valuable tool for providing diagnostic information. Several faculty development programs have taught faculty about computers and programming. Activities during the next year will include assistance in the development of units on applying computer technology to specific curriculum areas. According to the Committee on Computer Applications within the College of Education, all future graduates of the school will need to have a functional knowledge of the use of the microcomputer as a means of problem-solving and as an instructional tool.

West Virginia University has provided more than 400 elementary and secondary teachers and administrators with computer literacy education classes around the state during the past year. The courses are intended to provide initial training so that the teachers and administrators can continue on their own to learn about and use computers.

The IBM Corporation is sponsoring a program in New York, California, and Florida in which college professors are trained to teach secondary teachers how to teach computer literacy. IBM has donated computers to the participating universities and schools. In the SREB region, Florida Atlantic University and the University of South Florida are participating.

A summer program at Western Carolina University was one of the projects funded by the National Science Foundation to find means of improving science and engineering instruction at the pre-college and early college levels. Teachers learned primarily how to become instructors in the new College Board Advanced Placement course in computer science. The emphasis was on learning to program in PASCAL, the language used by the College Board's Advanced Placement examination in computer science.

State and Local District Actions

Nationally, several states now have teacher certification in the area of computer education, including Texas in the SREB region. A recent report by the Florida Education Standards Commission recommends a separate certification in computer education, as well as an add-on endorsement for those who will be teaching the use of the computer. Moves to create additional state certification areas should be examined in relation to the proliferation of certificates and whether or not certificates should be given for broad fields rather than more narrowly defined subject areas.

Several states are proposing that courses in computer literacy be required for all teachers who are to be certified. The Standards Commission in Florida has recommended that all pre-service education programs include a computer component, that one half of the currently required hours to be taken for recertification could be taken in the area of educational computing, and that all teachers should be computer literate — with the Teacher Certification Examination including computer literacy items by 1986.

The Texas State Department of Education has published *Essential Computer Competencies for Educators*, which outlines competencies for all public school educators in the state. The competencies, which are given in detail, deal with education applications and how to implement computer-based instruction, including the changes in structure of the classroom that must accompany the use of computers. The development of positive attitudes about the use of technology, familiarity with software, and the ability to use a high level programming language, such as BASIC, PASCAL, LOGO, or PILOT, are included. Educators should be familiar with various types of hardware, understand the place of computers in society, and the trends in the field.

In Georgia, several projects to aid and train teachers are underway. A one-year pilot project on staff development for teachers and administrators started in August 1983. Workshops geared to the individual needs of school districts, with training costs paid by the State Department of Education, will be held on an ongoing basis directed to instructional uses of computers. A joint venture of the State University System and the State Board of Education is a software library located at the University of Georgia that is available to teachers and administrators throughout the state. A task force within the State Department of Education has been appointed to coordinate all of the functions of each major department as they relate to the use of computers.

Colleges and universities are moving to include computer training for teachers at both pre-service and in-service levels.

The Tennessee proposal "Computer Skills Next" provides for statewide training of "experts" who will then train teachers. A training program would be provided for a building-level computer resource person who would teach computer literacy to students. All seventh and eighth grade teachers would receive training.

The Kentucky State Department of Education has held workshops for teacher training that have attracted hundreds of teachers. As a follow-up, $25,000 was provided for scholarships for teachers to attend university courses on computer education during the summer of 1983.

In Alabama, the Interim Commission on Elementary and Secondary Science and Mathematics has proposed that microcomputers be purchased for elementary and secondary schools and that teacher training be provided.

The Instructional Computing Project in North Carolina relies on an advisory committee to oversee its projects, which include statewide information on microcomputers and in-service training for teachers and administrators. The project was implemented in 1980 to coordinate and provide leadership from the State Department of Education for microcomputer activities.

In Louisiana, the Task Force on Computer Literacy advised cooperation between the State Department of Education and colleges of education to train teachers in computer education and how to integrate computers into K-12 instruction. The Task Force recommended that the state standards for approval of teacher education programs include standards for computer education.

In Arkansas, the Microcomputer Task Force, composed of school and higher education representatives, has urged colleges and universities to include computer literacy in their teacher training programs. It also recommends that certification requirements should be reviewed to determine to what extent computer literacy should be included, and whether or not a new certification area should be added for teachers of computing. The Task Force urges the State Department of Education to coordinate in-service training programs throughout the state at local or regional sites.

In Virginia, a task force of college and school personnel is studying in-service training for the state's teachers and has recommended a curriculum with increasing mastery of skills.

In Minnesota, a statewide effort at training teachers through in-service programs was started under the auspices of the Minnesota Educational Computing Consortium (MECC).

The consortium, created about 10 years ago, is a cooperative effort of the state's colleges and universities and public schools.

Legislation was recently signed in California which provides for a $30 million program for equipment, teacher training, and software development. The state will provide matching funds — $9 for every $1 that the district contributes. Grants will also be made to universities and colleges for teacher training programs.

Local districts vary in their approachs and resources to train teachers. Programs range from the comprehensive training that is provided through the district to localities which expect teachers to learn how to use computers on their own time and at their own expense. Many teachers gain training by attending conferences and sessions sponsored by professional organizations, such as the National Science Teachers' Association or the National Council of Teachers of Mathematics. The strategy of some school systems, such as those in Decatur, Georgia, and Lyons Township, Illinois, has been to provide training for all teachers before attempting to use computers with the students.

Software for Computers in the Classroom

The development of effective software is quite limited at this time — much educational software is of poor quality and is not suited for classroom objectives. Earlier technologies often failed because they did not fit the needs of the teachers and the classroom; microcomputers could easily fall into the same pattern of misuse.

Software for schools is a small part of the total market, and development of sophisticated software is often more expensive than can be warranted by the return that can be expected. For software to be useful, it often must be pointed toward a small segment of the total school population — a fourth-grade mathematics class, for example. In addition, software produced by colleges and nonprofit organizations further clouds the market for commercial firms. More educational software is currently sold for home computers than for school use, according to the Dallas-based research firm, Future Computing Inc. Illegal copying is also a concern that discourages software manufacturers from entering the school market.

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According to Kenneth Komoski, executive director of the Educational Products Information Exchange (EPIE), many products are not meeting the needs of educators. EPIE has recently joined with Consumers Union to study computer projects and evaluate them. Evaluations by the EPIE staff of software produced for schools have led to several observations: large scale software packages have not been developed for high schools; software seems to be designed predominantly for mathematics classes in the drill-and-practice mode; little emphasis is given to any higher order skills, such as analysis and synthesis of materials; and most programs provide little diagnostic help. Komoski feels very strongly that control over devices used in the classroom must be put in the hands of the educators. He notes that publishers of textbooks, for example, have not been held accountable for what is included in texts and that methods which have no research base often become standards.

Becker comments that the software rarely relates to curriculum and is usually written for particularly focused content, with very little continuity with other software packages. In addition, very few programs take a student into problem-solving or creative tasks. The potential for the use of the computer in the classroom is great, but will not come to pass until those using the computers demand something different from what they are now getting, according to Komoski.

The National Science Board's Commission indicates that materials appropriate to the needs of teachers must be produced and that presently a substantial gap exists concerning the usefulness of the current materials as viewed by those who produce them and by the teachers who use them.

To address the problems of inadequate software, district, state, and national level efforts are underway. At the national level, Secretary of Education Terrel Bell has called for a federal project on software development for school use. He has noted that federal initiatives are needed to develop adequate software to meet the standards of educators. Another proposal, recommended by Joe B. Wyatt, chancellor of Vanderbilt University, calls for joint government/industry cooperation to underwrite software projects. The projected budget for 5 years is $500 million. The major goal would be to underwrite efforts of teams of teachers and technology experts to develop and test material as well as train other teachers. In recent testimony before Congress, M. Joan Parent president of the National School Boards Association, called for a national program to develop computer software, but emphasized that educators and students at the local level must be directly involved.

The National Institute of Education recently funded a $7.7 million

center at Harvard University to study the instructional uses of computers in various subjects. The research will focus on the computer as a tool to aid teachers in instruction; emphasis will be on problem areas in the teaching of mathematics and science.

A joint effort of the EPIE and Consumers Union is providing information on all educational computing products, including evaluation of software for most curriculum areas. This type of service is also being provided on state and local levels. The Minnesota Education Computing Consortium (MECC) has furnished this type of service for state districts for several years, as well as for subscribers from outside the state. MECC also creates software packages. Larger districts, such as the Houston Independent School District, are evaluating software in a centralized location and aiding schools in deciding how computers can be used most effectively.

Conclusion

The nation is becoming increasingly dependent on the use of information exchange through modern technology. Its impact on education, both in higher education and in elementary and secondary schools is already substantial. The use of computers in the classrooms of elementary and secondary schools is rapidly increasing, as computers become more commonplace outside of schools and as the public demands that students become "computer literate."

Because of factors such as limitations on student access, inadequate teacher training, and inadequacy of software, the realization of the full potential of computers in education is far from complete at this time. It is clear that further efforts at the national, state, and local levels are needed to address the use of computers in the classroom.

Colleges and universities must be willing to use their resources to aid schools in research on computer use, as well as for teacher training. Not only will faculty of the colleges of education need to become involved, but faculty in the arts and sciences should help in developing methods of using the computer as a tool in learning the disciplines. Are colleges and universities in a position to do this? Many faculty members are still at early stages in their understanding of computers and their use. A first step may be for faculty members to appreciate the implications of the use of the computer before that knowledge can be imparted to anyone else.

Long-range plans should be made by states and districts in preparing for the use of computers in the classroom. While computers are being bought in great numbers, the question of what to do with them is often avoided. On the other hand, unless computers are available to students, no one can learn how best to employ computers in the educational system. It will certainly take experimenting with strategies and the willingness to change when obstacles are encountered.

States need to address equity questions concerning access of students to computers, and whether uses are being unfairly determined by the socioeconomic status of the students in a school. Evidence indicates that the use of the computer for higher level learning tends to be prevalent in wealthier schools, while drill-and-practice is more common in the poorer schools. Education of those teachers presently in the classroom will need to be addressed by states to provide better staffing and resources and to eliminate duplication of costly efforts.

Colleges and universities must be willing to use their resources to aid schools. . . .

Local districts will be responsible ultimately for determining the extent to which computers are used to fulfill their potential in the best interests of the students they serve, although not without statewide assistance. Local districts must not depend on teachers to accept the responsibility on their own to become fully knowledgeable about the use of technology in the classroom. The process will not occur with a few workshops on using the computer — there must be a sustained effort in training. Discipline-oriented groups for teachers, such as the National Council of Teachers of Mathematics and the National Science Teachers' Association, may be helpful by providing information to members about exemplary programs in their members' respective disciplines.

Federal initiatives, such as the recently funded center at Harvard, and efforts in research and software development are needed — not to impose on states and districts what should be done, but to provide the resources that should be available at state and local levels.

In the move for fuller use of technology in the classroom, educators and policymakers need to be open to the fact that present structures may have to change. On the other hand, change for the sake of change, or the acquisition of computers because it seems to be the thing to do, is not warranted. With careful planning and coordinated efforts at many levels, the full potential of the computer in the classroom can be realized. The bottom line is to help students to acquire knowledge more efficiently, to prepare for an unknown future in which information technology will play an important role — even if that role is still unclear — and to lead meaningful lives.

This edition of *Regional Spotlight* was prepared by Lynn M. Cornett, SREB research associate.

For Further Reading

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